

## TANIA - Overview of (Nano)remediation Challenges

### Introduction

#### *Document Objectives*

The present document summarises the findings from exchange among TANIA project partners throughout the first year of work (2017). It is designed as a tool to support further exchange in Project Year 2 (2018). During Year 2, partners and their stakeholders (TANIA Project Stakeholders – TPS) move from activities designed to set the scene for their territories and understand the nanoremediation concept (step 1 of activities), towards interregional and regional exchange to Merge Expertise, thus identifying practical policy solutions to nanoremediation challenges.

TANIA partners participate in the project, as they believe that nanoremediation can provide opportunities for their regional remediation activities. They started the project seeking to understand whether or not the following hypothesis can be relevant for their regions.

#### **HYPOTHESIS**

Nanoremediation has the potential to provide significant comparative advantages in relation to current, time-consuming solutions for remediation of polluted soil and water. It is an innovative, low cost technology, with the potential to save time and money in treating several types of contaminants, with minimal risks in terms of production and use. Nanoremediation can provide excellent environmental and economic opportunities, especially through opening of new markets, strengthening of circular economy and creation of new jobs.

Should this hypothesis prove correct, partners could design the best way to insert the concept into their selected regional policy instruments.<sup>1</sup>

#### *(Nano)remediation*

During the first year of exchange, project partners specifically requested that the scope of project analysis be widened to cover not only nanoremediation, but also novel techniques for remediation in general. Indeed, partners believe that nanoremediation should not be considered as a possible miracle cure, but rather as a solution that could be added to the remediation toolbox of combined, innovative techniques.

TANIA deals with innovative solutions for environmental remediation based on advanced materials (not just nano). Moreover, when we talk about nanoremediation we do not only mean nano-sized materials injected into the environment, but also nanostructured materials (use of advanced materials, with smart features). This can be macro-sized material, whose nano-structuring has created different and strengthened capacities, for example greater filtration capacity, absorption, capture of specific pollutants, etc. Nanoremediation also includes biocompatible nano-containers (for example, already tested in medicine, or used in agriculture) with ability to carry and to deliver

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<sup>1</sup> Policy Instruments for each TANIA region are listed on the project website: <https://www.interregeurope.eu/tania/>

substances that can address pollutants to the right place, in the right moment (nano-carrier, nano-delivery).

To this end, partners agreed on a simple technique to clarify the fact that the project covers nanoremediation and other innovative techniques for remediation. In project documents, the phrasing “(nano)remediation” will be used.

***Challenges to (nano)remediation***

Some challenges limit diffusion of nanoremediation and full exploitation of its benefits. During the TANIA application phase, 5 main challenges were grouped in categories of requirements for policy intervention and support. Following work carried out at regional and project level, challenges were reassessed to 6 by project partners, decoupling “pilot applications” from “patenting” activities, better responding to partners’ needs.

These challenges are listed and described as follows:

UNDERSTANDING (NANO)REMEDIATION: the Policy Challenges	
Challenge 1	Need for <b>public support for Research and Innovation on identification</b> and production of eco-compatible and eco-sustainable nanotechnology for treatment of contaminated soil and water (innovative solutions)
Challenge 2	Need for a <b>standardised methodology</b> to evaluate effectiveness, economic sustainability and environmental safety and impact of nanoremediation, within the context of National and EU regulations (e.g. REACH on packaging and labelling of chemical substances) and strategies (e.g. EU Soil Thematic Strategy)
Challenge 3	Need for public support to activities for <b>pilot applications</b> of NM and NP (including those developed using safety-by-design concepts)
Challenge 4	Need for public support to encourage <b>patenting</b> of NM and NP tools for remediation
Challenge 5	Need for public <b>incentives for in-situ use</b> of NM and NP to treat contaminated soil and water
Challenge 6	Need for public support to raise <b>awareness</b> on the process of (nano)remediation, its benefits and means of application, thus overcoming public fears and resistance

**Regional Ranking of TANIA Challenges**

Partners undertook an assessment of the challenges in relations to regional characteristics and needs. In cooperation with local stakeholders, they prioritised each challenge as follows:

CHALLENGES	TUSCANY	PÄIJÄT - HÄME	GRANDEST	BARANYA	CRETE
Research and Innovation	HIGH	HIGH	HIGH	HIGH	HIGH
Standardised Methodology	HIGH	HIGH	MEDIUM	HIGH	MEDIUM
Pilot Applications	MEDIUM	HIGH	HIGH	LOW	MEDIUM
Patents	LOW	MEDIUM	LOW	LOW	LOW
Incentives for in - situ Use	HIGH/MEDIUM	HIGH	MEDIUM	HIGH	MEDIUM
Awareness	HIGH/MEDIUM	HIGH	LOW	HIGH	HIGH

The following sub-sections describe the motivations for this prioritisation and some areas of interest emerging from exchange.

### ***Challenge 1 – Public Support for R&I***

The relevance of public support for Research and Innovation is highlighted by its overall priority level among partners. It is the only one identified with the highest ranking by every participating region.

Reasons for such prioritisation are linked to the necessity to obtain strong research results to prove or disprove the above mentioned hypothesis about application of (nano)remediation techniques.

Considering the novelty of nanoremediation techniques and nanotechnology more generally, funding for R&I should cover analysis related to:

- Safety and efficiency, to be demonstrated firstly at lab scale, in order to overcome present high degrees of uncertainty.
- Environmental needs: vast amounts of contaminated areas in every region require new solutions to be found for guaranteeing effectiveness, efficiency and sustainability.
- Links between academia and business sector, to translate theoretical findings into applicative tools. Collaborations between research organisations and enterprises are recognised as fundamental to open new markets and boost economic opportunities.

It is also important to analyse how support to Research and Innovation is allocated. In particular, TANIA partners believe that funds should be easily accessible and manageable to research organisations and enterprises. This aspect should be further analysed with reference to each region's selected policy instrument.

### ***Challenge 2 – Standardised Methodology***

Following the 1<sup>st</sup> Challenge, the need for a standardised methodology is identified by partners as the second most important issue to be addressed. Challenge n. 2 received the highest degree of relevance by 3 regions (Tuscany, Pajjat-Haame and Baranya County) and a medium priority by the remaining 2 regions (GrandEst and Crete).

Due to its innovative features, nanotechnology for remediation would benefit from a standardised methodology to evaluate, monitor and control the proposed technological solutions. However, there is currently an absence of an European regulatory framework on (nano)remediation and of subsequent legislation at national levels.

This methodology should include common standards and procedures, which allow the relevant authorities and other end users (e.g. land managers) to assess the costs and benefits of a (nano)remediation application in a particular polluted area. The methodology should cover, among others, health and safety issues, costs, potential results and data in comparison to traditional techniques. It would also allow for a standardised comparison of research results.

### ***Challenge 3 – Pilot Applications***

Pilot Applications were generally awarded an intermediate level of priority. However, its prioritisation is expected to increase at a later stage of analysis.

Partners consider that pilots are significant to demonstrate (nano)remediation techniques and their effectiveness. They can also demonstrate the conditions that are required for these techniques to be applied successfully. Policy makers are interested not only in lab results, but also in practical illustrations of how a specific technique works in their own region to address their specific pollutants. Moreover, pilots can be used to make a comparative analysis of techniques in different geographical areas and as applied to different pollutants / polluted areas. When planning a pilot action, it is important to consider in advance the available expertise and financial resources. Indeed, multi-disciplinary knowledge and experience may be required.

### ***Challenge 4 – Patents***

Patenting received the lowest ranking in partners' prioritisation. Almost every participating region expressed a limited interest on this challenge.

At the moment, patents are considered premature, mainly because of low diffusion of such remediation techniques, scarce use and consequently a very small reference market for (nano)remediation solutions. Moreover, high costs for patenting procedures reduce interest for stakeholders at present stage.

### ***Challenge 5 – Incentives for In-situ Use***

The relevance of incentives for in-situ applications received an overall medium/high level of interest. Every region identified the issue as relevant, raising however uncertainties.

Public incentives are generally deemed a relevant leverage to consolidate and provide follow-up to results achieved through research and innovation projects/activities. Given the lack of resources allocated to research, incentives for in-situ applications can encourage comparative analysis and, consequently, the use of more cost effective and eco sustainable solutions.

However, before in-situ usage, efficiency must be tested and proven (see the above described challenges). Financial support is crucial to promote market-viable results from R&I projects. As there are limited resources available, there must be an effective evaluation process to ensure that

funds are allocated to the most cost-effective solutions. Therefore, before selecting methods, there must be a comparison between the available techniques.

### ***Challenge 6 – Awareness***

Awareness raising on (nano)remediation issues is identified of medium/high importance in every participating region. It is considered as a horizontal issue to the more technical challenges above and it ranked among the most relevant challenges.

Throughout the whole partnership territory, a general lack of culture on (nano)remediation notions and techniques is recognised. This is true among all groups of stakeholders: managing authorities, potential end users, contractors and civil society. The importance of awareness on (nano)remediation is linked to its role of preparing the ground for its applicative use and market opening. A wider knowledge of solutions offered by nanotechnology entails a potential wider diffusion of its usage.

However, badly designed dissemination and awareness campaign can generate opposite results, especially because of negative connotations that often surround the term nanotechnology. Facts and data generated through comparative analyses will play a crucial role in educating authorities, business actors and public audience concerning existing solutions and their potential outcomes.

### ***Links between Challenges***

Links among challenges emerged from the exchange process. This underlined that fact that, in order to provide tailored policy instruments in support of (nano)remediation, it is necessary to consider not only the single identified challenge, but also the linkages between them. A selected policy tool should attempt to provide a comprehensive approach.

The most significant links identified are as follows:

- Challenge 1 with Challenge 2 – Support to Research and Innovation represents an opportunity to overcome current legal uncertainty and administrative complexity, generally seen by partners as hindering the use of novel remediation techniques. Research results are the basis upon which a standardised methodology will be build. They can lead to the development of a monitoring scheme for empirical applications. Permission to deploy novel techniques and their regulation must be based on a standardised methodology founded on solid research outcomes.
- Challenge 1 with Challenges 3 and 5 – In order to obtain effective and efficient solutions for (nano)remediation, techniques and procedures need to be studied and tested on real sites with different soil/water and climate conditions for different contaminants. To this end, applications in practice demand solid research on which pilot operations can be designed. As research is necessary to pilots, applicative demonstrations are basic to actual utilisation of (nano)remediation. Regulatory and financial incentives can be developed and implemented only through previous research and testing activities.
- Challenge 3 with Challenge 6 – Implementing pilot actions is probably the best way to feed the public debate on safety of (nano)remediation techniques with consistent data. Perplexities from public authorities, business actors and civil society can be dissolved thanks to practical evidences of effectiveness and security of novel solutions exhibited through empirical analyses, resulting in wider acceptance and therefore support.

## Input from External Experts

Alongside the Exchange of Experience carried out by project partners, several external experts took part in the process. Their input confirmed the relevance of the challenges identified at project level and provided some extra input and expertise into each

- Some particularly significant contributions provided during TANIA Exchange Event 2 (Pécs (HU), 22/23 May 2017) and 3 (Metz (FR), 28/29 November 2017) are described as follows: TANIA Exchange Event 2: Petr Kvapil, Photon Water Technology (NanoRem Project)<sup>2</sup> participated as an invited stakeholder. Crucial aspects, common to NanoRem and TANIA projects, to be taken in consideration include the need for a comparative analysis of pros and cons of different techniques, in relation to risks, benefits and costs. Monitoring activities are fundamental to implement modelling and forecasting systems, as well as for creation of assessment tools. Challenge n. 2, referring to a standardised methodology, is to be addressed in order to translate research into marketable products and processes. To this end, Challenge n. 3 also appears central. Pilots are necessary, especially in consideration of the complexity in addressing the employment of novel techniques for remediation, characterised by being highly site specific.
- TANIA Exchange Event 3: During 2 round table sessions, a number of local and interregional stakeholders participated in order to provide their input on technical and policy related challenges<sup>3</sup>. The full report of their input is provided in the minutes of this event. Some examples of their input are summarised here. Philippe Bataillard, BRGM (Bureau de Recherches Géologiques et Minières) discussed how demonstration sites (Challenge n. 3) are needed to exhibit benefits deriving from novel, untested remediation techniques. Besides showing results, hazards, risks and costs should be carefully evaluated through deployment of innovative materials. Franck Le Moing, ADEME - (Agence de l'environnement et de la maîtrise de l'énergie) highlighted how research needs are relevant and, therefore, support to Research and Innovation activities (Challenge n. 1) should be provided to deepen analyses. Identifying a standardised methodology (Challenge n. 2) would help management plans for remediation to be accepted by public authorities. Incentives for in-situ use of (nano)remediation (Challenge n. 5) are important to stimulate depollution of contaminated areas, while addressing Challenge n. 6 with public awareness campaigns can encourage a change in current approaches and solutions. Carlo Punta, Politecnico di Milano, confirmed the importance of research to pave the way for all future developments and application (Challenge n.1). He stressed that research projects should have a multi-skill dimension (e.g. the core importance of including eco-toxicologists in defining validation protocols and in a proactive role to understand potential applications) and discussed the possibility to link work to other area of work, such as the circular economy. He confirmed that research is linked to standardisation (Challenge 2). It is necessary to define need validation protocols and specific restrictions, rather than blanket-refusal to use nano. These should also cover nanotech design (how to choose the material, from renewable and eco-safe sources).

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<sup>2</sup> NanoRem (Taking Nanotechnological Remediation Processes from Lab Scale to End User Applications for the Restoration of a Clean Environment) was a research project, funded through the European Commission FP7. More details are available here: <http://www.nanorem.eu/>.

<sup>3</sup> The full list of stakeholder participants is as follows: Carlo Punta– Politecnico Milano; Johanna Kilpi-Koski – LADEC; Hannu Silvennoinen - Nordic Envicon Oy Ltd; Philippe Bataillard – BRGM; Philippe Liautard– DREAL Grand Est; Frédéric Gouyau - DREAL Grand Est; Régis Stenger– EPFL; Franck Lemoing – ADEME); Christophe Chene – SOLEO); Marie Odile Simonnot - University of Lorraine; Laure Giamberini - University of Lorraine; Maria Vamvakaki - University of Crete/Department of Materials Science and Technology

In addition to the reported recommendations, inputs from several other external experts stressed a further notion. Technical and technological issues are extremely diverse in relation to polluted sites, contaminants, and local legal frameworks. Therefore, to plan successful public support for the uptake of innovative remediation techniques, multidisciplinary competences are needed. The selected policy instruments should also promote cooperation between actors from different fields, involvement of end-users, consultation of stakeholders and civil society.

## **Conclusions**

This document has provided an overview of the results of experience exchange in Year 1 of the TANIA project. In this final section, we attempt to summarise the information provided by each region about their needs (why they indicated specific challenges as important). Moreover, in some cases, we offer an input into how regions are thinking of starting to address these challenges..

### ***Conclusions on specific regional point of interest***

Tuscany enjoys the advantage of having nanotechnology already present within its Smart Specialisation Strategy. The work undertaken to introduce such specialisation within the RIS3 and the present effort to update the Strategy for the future Programming Period could be helpful for partners interested in improving respective ERDF governance/focus. However, despite this, nanotechnology is not directly connected to the environmental sector. For this reason, Challenge n. 1 (Support to R&I) and 2 (Standardised Methodology) are particularly relevant to translate existing potential into applicative measures. It is also of high interest to link up research to the private sector. Some enterprises and research institutes already have solutions to share. Pilot actions (Challenge n. 3) may help in easing the legislative gap that holds back implementation of applicative solutions. Finally, Tuscany Region has launched the “Platform 4.0”, an integrated structure aimed at supporting enterprises in moving towards Industry 4.0. This platform involves public authorities and research centres. Such a tool could represent an opportunity for information and awareness raising purposes (Challenge n. 6).

Päijät-Häme is strongly business oriented. However, regional enterprises do not currently possess ready-to-use nanotechnologies for remediation. High interest on Challenge n.1 derives from the presence of prominent research facilities and resources in the field of remediation. Moreover, research potential is coupled with a regional advantage due to greentech oriented ERDF. Incentives for in-situ use (Challenge n. 5), standardisation and certification (Challenge n. 2) may help to involve enterprises and authorities. It is worth mentioning that an intermediate call for “Experimenting and Pilots in New Growth Areas” is planned for early 2018 in Päijät-Häme, into which (nano)remediation references are tried to be inserted. Regional partners who also wish to improve own policy instruments or intermediate calls could observe/cooperate in the lobbying activities.

GrandEst, as for the previous partners, has a pronounced focus on market opportunities for business. Prominent research facilities and know-how are already involved in remediation and reclamation activities, due to environmental and historical characteristics. Such reclamation policies and research background determine high interest in Challenge n.1, 2 and also in potential patenting initiatives (Challenge n. 4), thanks to existing applicative novel solutions to be transferred. The main goal is promoting new jobs and companies through comparative testing of performances of innovative processes. Finally, in 2018 an intermediate call for “Innovation in In-situ Techniques” will take place, being an opportunity for inserting into it learnings from the TANIA Exchange of Experience and for cooperation with partners undergoing similar conditions.

Crete is home to a flourishing research sector and lays the foundation of its economy on a healthy environment. However, it holds no expertise in (nano)remediation techniques. Interest in combining innovative technologies with traditional solutions has been expressed, linking especially to standardising methodologies and patenting (Challenge n. 2 and 4). Public authorities are currently carrying out a redefinition of focus topics under the Knowledge pillar of the regional strategy (Challenge n. 1). Consequently, there is room to update and improve efficiency of ERDF including findings and content from TANIA Exchange of Experience. To this end, the political process that led to the present RIS3 in Tuscany could be a frame of reference.

Baranya expressed the lack of resources as the main limitation to be handled, in combination with low Research and Development intensity at national level (Challenge n. 1). However, there are opportunities to engage resources from the National Environmental Remediation Programme, in order to provide incentives for in-situ use (Challenge n. 5). Moreover, in order to stimulate uptake of (nano)remediation, education of public authorities, companies and tenderers is recognised as pivotal. Measures connected to Challenge n. 6 (e.g. Tuscany) could be evaluated.

### ***Pilot Actions within TANIA***

Every participating partner highlighted a particular attention to the Challenge n. 3. At present stage, pilots probably represent the best solution to promote (nano)remediation at every level. In fact, application on the field is interconnected with every other identified challenge.

However, pilot tests require a significant amount of financial resources and cannot easily be financed by the Interreg Europe Programme. Interreg Europe is principally focused on exchange of experience. However, the project does foresee the possibility to apply for Pilot Actions to test new approaches at the end of Phase 1. In particular, project partner can apply to specific funding dedicated to transfer and implement existing or jointly designed practices. However, these pilot proposals must respond to a certain set of criteria<sup>4</sup> and there is no guarantee that they will be funded. Moreover, the timing may not be suitable for TANIA regions (who would be interested in demonstration activities at an earlier time).

Therefore, an alternative could be to apply for funding with the H2020 Research programme. To this end, calls are being taken in consideration to evaluate applications by an international consortium. More precisely, two H2020 calls are deemed of interest: “Strengthening international cooperation on sustainable urbanisation: nature-based solutions for restoration and rehabilitation of urban ecosystems”<sup>5</sup>, and “New biotechnologies for environmental remediation (RIA)”<sup>6</sup>.

### ***Effective Interregional Exchange in TANIA Year 2***

To conclude, outcomes on challenges emerged during the 1st Year can be valuable with a view to setting up the work for Year 2, when projects partners and stakeholders will use the exchange of experience to merge expertise. After having set the scene to determine characteristics and needs for

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<sup>4</sup> Policy relevance - Are the pilot actions clearly related to the issue addressed by the project? Do they clearly contribute to the improvement of the policy instrument addressed by the project? In case of success, is there any plan for generalising the pilot actions and how? What durability is envisaged for the pilot actions? Can it lead to long-term results in the regions? Are they in line with state-aid rules?

Interregionality - Does the pilot action clearly derive from the interregional exchange of experience process? Is it clearly related to a transfer of practice from another region or from a new approach jointly developed in the project?

Additionality - Is it clear that the pilot actions would not take place without the programme’s financial support? Is there clear evidence that the pilot actions cannot be currently supported by local / regional / national funds?

<sup>5</sup> <https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/sc5-13-2018-2019.html>

<sup>6</sup> <https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ce-biotec-04-2018.html>



their territories, work will focus on identifying practical policy solutions to (nano)remediation challenges. Partners will undertake bilateral and multilateral cooperation to select and exchange solutions. This cooperation will be defined on the basis of emerged similarities and differences in terms of focus on challenges and of interest in the solutions proposed to meet these challenges. This work is functional to the definition of a Regional Action Plan in each participating territory, where policy improvements will be defined thanks to interregional cooperation within TANIA.